Tipp 2014 - Third International Conference on Technology and Instrumentation in Particle Physics

Contribution ID: **52** Type: **Poster**

Deformation Monitoring of a Tracking Particle Detector using Fiber Bragg Grating sensors

The frontier evolution of a gaseous tracking particle detector technology has been moved in developing Micro-Pattern Gas Detectors that can achieve unprecedented spatial resolution, high rate capability and large sensitive area. However, also the geometry of such kind of tracking detector, in spite of the particular technology used, has to be known with a precision of the order of few tens of μm. The relative position of each detector with respect to a reference system is usually measured through optical sensor elements (CCDs, lenses, light sources), but also any deformation (bending, strain, torsion) with respect to its ideal shape has to be monitored as well. From this consideration, a real-time sensing technology capable to detect any curvature and deformation of a detector with a resolution of few tens of μm is desirable. However any sensor to be integrated with the detector itself should ideally comply with many requirements in terms of radiation hardness, insensitivity to magnetic field, and so on. Fiber Bragg gratings (FBGs) seem to provide a suited solution. In fact, the fiber itself can tolerate very high levels of radiations, is insensitive to magnetic field and electromagnetic noise, and FBGs are intrinsic strain and temperature sensors with wavelength-encoded information, offer high multiplexing capability with reduction of cabling complexity and linear output.
In this work FBG technology is proposed as suitable sensing solution for the real-time deformation monitoring of a tracking particle detector. As a demonstrative target, some FBG sensors have been integrated with a miniature detector support panel in order to investigate their potentialities/capabilities in detecting local strain and thus bending. Preliminary experimental results are presented and discussed.

Summary

Our case of study is to use an FBG sensors with a micromegas (an abbreviation for "micro mesh gaseous structure"(MM)), that is a micro patter gas detector. One mandatory issue for the correct operation of the MM detector is a precise monitoring of its panels'flatness/deformation. The basic idea, proposed here for the first time, relies with the development of a deformation monitoring system based on FBG technology, where several FBG strain sensors are surface attached to both detector support panels. Measuring strain on both sides of the panel it is possible to obtain its local curvature that is related to the second derivatives of the shape described by the bent surface. Actually, if a planar surface is bent, a positive strain (tensile) is induced on a side and a negative strain (compressive) is induced on the other one: curvature is proportional to the their relative difference. On the contrary, if a same sign strain is measured on the two sides of the surface, a longitudinal deformation of the surface can be derived.
Following this idea, the whole surface of the support panels can be subdivide into a proper number of elements that undergo simple deformation. Each element will be monitored by using FBGs attached to the surface of the panel. A mechanical Finite Element Method analysis of a full size support panel is necessary in order to determine the number and the dimension of these elements, taking into account the mechanical properties of the panel and performance requirements.
The sensing principle of a fiber Bragg grating can be expressed as $\Delta\lambda_B/\lambda_B = S_\varepsilon \varepsilon + S_T \Delta T$ where λ_B is the original Bragg wavelength under strain free and initial temperature condition, $\Delta\lambda_B$ is the variation in Bragg wavelength due to applied strain ε and temperature variation ΔT, and S_ε and S_T are the sensitivity coefficients to strain and temperature, respectively. It is worth noting that in order to measure the strain of an host material, temperature compensation of the FBG sensor is required. The resolution of these technology is

of the order of 1 με , suitable for the physical requirements on the detector geometry.
The obtained results prove that the proposed approach has the potentialities to permit a continue monitoring of the deformation and bending of the detector.

Primary author: Dr DELLA PIETRA, Massimo (Engineering Dept, University of Naples "Parthenope"and INFN)

Co-authors: Prof. IADICICCO, Agostino (Engineering Dept, University of Naples "Parthenope"); Prof. CAMPOPIANO, Stefania (Engineering Dept, University of Naples "Parthenope")

Presenter: Dr DELLA PIETRA, Massimo (Engineering Dept, University of Naples "Parthenope"and INFN)

Track Classification: Emerging technologies: 4e) Precision engineering